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SURFACE-LIGHT SOURCES

CLAIM(S)

1) A surface-light source structure, wherein a condenser consisting of opaque light diffusion plate and transparent material and a having top surface with continuous hemispherical bodies or a section with a continuous hemispherical curve or with parallel convex strips in polygonal mountain shape.

2) A surface-light source structure, as cited in Claim 1, wherein the distance between the centers of the hemispherical bodies in the continuous hemispherical bodies of said condenser is 0.5 mm or less, and the distance between the parallel convex strips is 0.5 mm.

3) A surface-light source structure, as cited in Claim 1, which is positioned between the surface-light source of a back light type color liquid crystal display and the liquid crystal element, and distance between the centers of hemispherical bodies or the space between the parallel convex strip is 0. 2 mm or less.

DETAILED DESCRIPTION OF THE INVENTION

(Field of Industrial Application)

The present invention pertains to a surface-light source structure that radiates light from the light source to a display screen of the display device to improve a brightness level on the display screen.

(Prior Art)

With display devices using light, it is desirable to improve a brightness level on the display screen without diffusing a luminous flux radiated from the display screen in the lateral direction.

For example, in case of a back light-type liquid crystal display (hereinafter referred to as an LCD), the LCD has an advantages of lightweight, thinness, and low power consumption relative to the prior art cathode tube display (CRT), and demand for its is rapidly increasing for use in portable televisions, lap-top personal computers, and wordprocessors. The LCDs are grouped into two types: a reflection type without a back light; a transmission type with a back light. The reflection type is dark and has a little contrast, which is difficult to view, so the transmission type with a back light is a main stream in this technology. The light source of the back light is primarily a fluorescent lamp, but its power consumption is large. Therefore, a light source that has low power consumption and is bright at the same time has been demanded. In an attempt to accomplish this purpose, a reflection sheet was installed behind a fluorescent lamp so that the light evenly and effectively permeates

through the liquid crystal element surface; a light-adjusting film was installed in front of the fluorescent lamp to adjust differences of brightness levels that are caused by different positions of the fluorescent tubes; and an opaque colored light-permeable light diffusion plate was installed.

Even by use of said reflection plate and diffusion plate, however, some portion of the light advances perpendicularly to the LCD element surface and other portion of light advances diagonally toward the periphery. This light advancing toward the periphery does not do any good to the liquid crystal element.

(Problems of the Invention to Be Addressed)

The inventors conducted researches on the method for improving the brightness level on the display screen or the LCD liquid crystal element screen of the a display device by minimizing the light advancing toward the periphery, and produced the present invention based on an idea that the light that is diffused toward the periphery can be refracted into the direction perpendicular to the display screen or liquid crystal element surface.

(Means to Solve the Problems)

The present invention presents a surface-light source structure, wherein a condenser consisting of opaque light diffusion plate and of transparent material and having a top surface with continuous hemispherical bodies, or a section with a continuous hemispherical curve, or with parallel convex strips in polygonal mountain shape.

More specifically, the light advancing from the light diffusion plate toward the periphery of the display surface is refracted by said condenser into the direction perpendicular to the display surface as much as possible to increase the brightness level of the display screen.

The embodiment example of the present invention is explained below with reference to the drawings.

Fig. 1 shows a sectional view of the surface-light source of the present invention, wherein condenser 2 is overlaid on the diffusion plate 1.

The diffusion plate is structured by an optical diffusion system that uses a glass or plastic sheet with a roughened surface, a glass or plastic sheet mixed with a proper filler, a prism, or a lens.

For a condenser to have the aforementioned function, it has to have a group of minute hemispherical condensing lens-like bodies, a section with a continuous hemispherical curve, or with parallel convex strips in continuous polygonal mountain shape looking like the halves of a square.

More specifically, the condenser is, as shown by its partially expanded view in Fig. 2, is made of transparent glass or plastic sheet, and its sectional shape has parallel convexities forming continuous hemispherical curves, or its top surface has a group of hemispherical bodies, as shown by its partially expanded view in Fig. 3.

The distance between the centers of said minute lens-like bodies is 0.5 mm or less, and in case of liquid crystal color display, it is preferably 0.2 mm or less to

avoid a moire effect caused by the light interference with the liquid crystal element.

In the embodiment example of the present invention, the diffusion plate and the condenser are separately formed, but both may be integrally formed.

Fig. 5 shows a sectional view of the fluorescent lamp of the back light type light source mounted with the surface-light source structure viewed from the direction perpendicular to its tube axis. The fluorescent lamp 4 is installed in the housing, the rear surface of which is the reflection plate 5. On its front surface, the light adjusting film 3 is formed. On the light adjusting film, the condenser 2 with the diffusion plate 1 is installed.

(Operation)

The diffused light coming out of the diffusion plate goes into the condenser, and goes out of each minute condensing lens-like body of the condenser in form of refraction light. At this time, the incident light near the boundary (the light with a large incident angle) of the minute lens-like body is refracted into a smaller refraction angle than its incident angle at the emission surface shown in fig. 4. Accordingly, the diffusion light from the periphery of the diffusion plate is more refracted inward, which improves the brightness level of the liquid crystal element surface.

The example of improving the brightness level of the back light type LCD is explained above, but the present invention is applicable likewise for improving the brightness level of a display screen for displaying characters and drawings or of an

advertizing board by radiating the screen by the light source behind the screen.

(Embodiment Example)

The present invention is explained further with reference to the embodiment example.

By using the LCD back light shown in Fig. 5, the surface brightness level was measured in the case when the condenser of the present invention is mounted and in the case when the prior art diffusion plate alone is used.

The surface-light source comprised: two cool cathode tubes (diameter 7 mm ϕ, lamp voltage 200 V, lamp current 6 mm A); reflection sheet (5) (white plastic molded product with reflection index 85% or higher); light-adjusting film (3) (a plastic film with a locally variable transmittance/reflection index for equalizing the brightness levels of the upper section of the fluorescent lamp and of its periphery); diffusion plate 1 (mixed with white filler and its total light transmission 58%). The longer lateral parallel to the cathode tube is 200 mm and its shorter lateral is formed in an angular shape with 140 mm.

The condenser 2 has a sectional surface with continuous parallel convex trips forming a continuous hemispherical bodies with a 0.15 mm diameter. As for the measuring position, the central position of the polygonal surface-light source plate is marked as No.3, and No.1, No. 2, No. 3, No. 4 and No.5 are marked at every 2.5 mm space interval on the center line parallel to the shorter lateral.

The result of measurement is shown in Table 1.

Table 1 (unit: nit)

Measuring positions	embodiment examples (with condenser)	comparative examples (with no condenser)
No. 1	610	510
No. 2	685	580
No. 3	590	515
No. 4	680	590
No. 5	580	500
average	629	539

From Table 1, it is obvious that the brightness level is improved 10% or more by the present invention.

In addition, when said surface-light source structure was incorporated in the colored LCD, the LCD screen surface had more brightness. With the case when the distance between the parallel convexities was 0.5 mm, the bright and dark waves were generated on the LCD screen, which was disturbing to eyes.

(Advantage)

According to the present invention, the brightness level can be improved 10% in case of the liquid surface-light source, so the present invention is extremely useful for a back light type liquid crystal display.

In addition, the present invention is very useful for improving the brightness level when applied to the display surface that can be radiated from behind, such as a display board for emergency exit, stairwell, or for a advertizing board.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a sectional view of the surface-light source structure of the present invention. Fig. 2 shows a perspective view of partially expanded condenser as one embodiment example of the present invention. Fig. 3 shows planar view of the partially expanded condenser as another embodiment example of the present invention. Fig. 4 illustrates the operation of the condenser. Fig. 5 shows a sectional view of the light source section of the back light type liquid display mounted with the surface-light source structure of the present invention.

1. Diffusion plate
2. Condenser
3. Light-adjusting film
4. Fluorescent lamp
5. Reflection sheet